

REMARKS

Claim 17 has been amended to cure informalities, unrelated to any prior art rejections. Claims 19-20 have been added, and claims 14, 16, and 18 have been cancelled. As a result, claims 1-13, 15, 17, and 19-20 remain pending. No new matter has been added.

As indicated in the Background section of the instant patent application, a variety of prior art techniques have been employed to provide automatic frequency correction in communications systems, such as CDMA. *See* Patent Application, page 2, lines 27-29. One prior art technique is to perform frequency correction at the input to the receiver, where the receiver has the highest sampling rate. *Id.* at page 2, lines 31-32. However, as noted, this technique demands a very high computation requirement. *Id.* at page 2, lines 32-34. An alternative prior art technique involves performing frequency error detection and correction after the signal has been de-spread, at the symbol level. *Id.* at page 2, line 34 – page 3, line 1. However, such a technique is limited in the range of frequency correction. *Id.* at page 4, lines 1-2.

The described and claimed invention is directed to performing an automatic frequency control in a receiver that receives an analog signal, converts it to digital signal, where the digital signal has a first data rate. In the illustrated embodiment, the digital signal is sometimes referred to as the signal with oversample chip rate (see Figure 3 of the patent application). As described in the patent application, the oversampling chip rate tends to be relatively high. The digital signal may be down-converted to a second signal having a second data rate, wherein the second data rate is smaller than the first data rate. One example of the second data rate can be the chip rate, as shown in Figure 3 of the patent application. The second signal may be despread to form the third signal with a third data rate, where the third data rate is lower than the second data rate.

One example of the third data rate can be the symbol rate shown in Figure 3 of the patent application. As noted in the patent application, performing frequency correction at the symbol rate can result in a limited range of frequency correction and performing frequency correction at the oversampling rate may be computationally expensive. In contrast, one or more embodiments of the present invention are directed to measuring a frequency offset at one rate level (*e.g.*, the symbol rate level) and implementing a frequency correction at another rate level (*e.g.*, the chip rate level). See Patent Application, page 7, lines 32-36.

The pending claims are directed to one or more of the above-described features. For example, claim 13 calls for a receiver for use in a spread spectrum communication system. The receiver comprises an analog to digital converter, a downconverter, a digital signal spreader, and a frequency corrector. The analog to digital convert is for converting an analog signal into a digital signal, the digital signal having a first data rate. The downconverter is adapted to downconvert the digital signal to a second signal having a second data rate, wherein the second data rate is lower than the first data rate. The digital signal despreader is adapted to process the second signal having the second data rate to obtain a despread digital signal having a third data rate, said third data rate being lower than said second data rate. The frequency corrector comprises a feedback loop including a frequency offset detector for obtaining a measure of a frequency offset from said despread digital signal and a frequency correction generator for generating a frequency correction, and a combiner for combining said frequency correction with said second signal to correct said frequency offset.

The Examiner rejected independent claims 6 and 13 under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 5,361,276 (*Subramanian*) in view of U.S. Patent No. 6, 621,

857 (*Belotserkovsky*). For reasons explained below, neither *Subramanian* nor *Belotserkovsky*, when taken alone or in combination, teach one or more claimed features of the pending claims.

As shown in Figure 2 of *Subramanian*, the receiver receives a complex digital signal 156 and converts it to a signal with a lower data rate using downconverter 106. The down-converted signal is provided to the rake receiver 103, which provides an output signal to the frequency offset estimator 114. The frequency offset estimator 114 and NCO 120 provide a frequency correct term signal 150 to the downconverter 106. Thus, drawing a parallel to the system disclosed in *Subramanian* to the claimed invention, the digital signal 156, output signal of the downconverter 106, and the output signal of the rake receiver 103 of *Subramanian*, would correspond to the respective “digital signal,” “second signal,” and “despread signal” of claim 13.

Subramanian further discloses that the downconverter 106 is:

re-
sponsible for automatically controlling the frequency of the complex digital signal 156. In other words, the downconverter 106 performs frequency offset correction. Preferably, the downconverter 106 performs frequency offset correction by modifying the complex digital signal 156 using a frequency correction term signal 150 generated by the digital feedback loop 130 (described below). Preferably, the downconverter 106 complex multiplies the complex digital signal 156 using the frequency correction term signal 150 to perform frequency offset correction.

Column 7, lines 4-15 (emphasis added).

As indicated by the underlined text, *Subramanian* teaches that the downconverter 106 performs frequency offset correction by modifying the complex digital signal 156. Thus, *Subramanian* discloses correcting the frequency offset at the sampling rate represented by the digital signal 156 (note that the digital signal 156 corresponds to the first signal having the first

data rate of claim 13). In contrast, claim 13 calls for performing frequency offset correction at the second sampling rate (*i.e.*, the second signal, and not the first signal), as it calls for combining said frequency correction with said **second signal** to correct said frequency offset. Note that, according to claim 13, the “frequency correction” is determined based on the despread signal having the third data rate. None of the cited references teach or suggest this claimed feature. By correcting the frequency offset at the sampling rate of the second signal (*e.g.*, chip rate), as opposed to at a higher sampling rate (such as that of the digital signal 156 of *Subramanian*), it is possible to reduce the amount of computational resources that are required to perform frequency correction.

Independent claims 1 and 6 are also allowable in view of one or more of the above-presented reasons with respect to claim 13. Additionally, for the same reasons, claims depending from these independent claims are likewise allowable.

The Office Action suffers for other shortcomings, not all of which are discussed herein in view of the above-noted deficiencies in the Office Action. Consider, for example, claim 5, which calls for, among other things, generating a correction sequence that is an up-sampled complex correction sequence $Z_{\text{offs}}(k)$, where k represents a given sampling instant, and where $Z_{\text{offs}}(k)$ is equal to $1 \times \exp \{j\phi_{\text{offs}}(k)\}$ where $\phi_{\text{offs}}(k)$ represents phase offset values at the first rate which are linearly interpolated from an average phase difference at the second rate. In rejecting claim 5, the Examiner asserts that the sampled complex correction sequence $Z_{\text{offs}}(k)$ of $\exp \{j\phi_{\text{offs}}(k)\}$ is shown at column 13, lines 45-60 and by the equation on line 60. The equation cited, and the associated text of *Subramanian*, describes the output of the NCO 120 (see Figure 1) that is applied to the downconverter 106. According to the Examiner, the output of the NCO 120 is

the frequency correct term signal 150, and this signal corresponds to the “correction sequence” of claim 1. See October 6, 2003 Office Action, page 2. The Examiner further asserts that *Subramanian*, at column 10, lines 34-39, column 10, line 46 – column 11, line 6, column 12, lines 45-55), teaches $\phi_{\text{offs}}(k)$, which represents phase offset values at the first rate that are linearly interpolated from an average phase difference at the second rate. The Applicants respectfully disagree, and respectfully traverse this rejection.

The text cited by the Examiner at columns 10, lines 34-39, does not describe the claimed “correction sequence,” where $\phi_{\text{offs}}(k)$ represents phase offset values at the first rate which are linearly interpolated from an average phase difference at the second rate. The cited text describes that the carrier phase must be estimated for each Rake element 108 before combining by the combiner element 110, and does not describe linearly interpolating the phase offset values at the first rate from an average phase difference at the third rate. Similarly, the other cited portions of the text also fail to describe these claimed features.

Claim 5 is thus allowable for at least the reasons set forth above. Additionally, newly added dependent claims 19 and 20 are also allowable for at least the reasons cited above with respect to claim 5.

In light of the above arguments, Applicants respectfully assert that claims 1-13, 15, 17, and 19-20 are allowable. In light of the arguments presented above, a Notice of Allowance is respectfully solicited.


If for any reason the Examiner finds the application other than in condition for allowance, the undersigned attorney hereby requests an interview with the Examiner to discuss the steps necessary for placing the application in condition for allowance.

Respectfully submitted,

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